PROTECTIVE CONTAINER AND ASSOCIATED METHODS

FIELD OF THE INVENTION

The present invention relates generally to containers for materials. More particularly, the present invention relates to containers which reduce the danger of adverse exposure to the container contents.

BACKGROUND OF THE INVENTION

Systems designed to contain materials rank among the oldest of human inventions. A wide variety of container types ranging from clay pots to refrigerated semi-tractor trailer tanks have been used to hold, dispense, and transport nearly every type of material imaginable. During the past century, many materials have been developed and used with greater frequency which require care in handling due to various adverse consequences if the material is inadvertently exposed. Therefore, a number of approaches have been used to minimize the risk involved in using and transporting these materials.

Various containers and packaging for containers are designed to protect contents during shipping or transport from inadvertent exposure. One common design has been to create an impact resistant outer shell which cushions the materials inside the container. Other containers may have impact resistant layers and/or spacing between outer and inner layers to decrease the risk of leaking or puncture of the container. Foam and other padding layers having preferred deformation characteristics have also been used as a measure of protection against various impact forces.

Another approach to protecting materials in a container during transport is through the use of various packaging materials. Such packaging materials often include adsorbent layers or agents which soak up any material discharged from a

ruptured container. These types of packaging layers form a physical barrier to prevent the fluid from leaking outside of the package. Such layers may also act as a cushion to reduce the chances of a container breach. Other packaging materials may contain compounds which interact with the container contents to minimize the consequences of accidental discharge.

Unfortunately, protective packaging materials provide no continued protection for a container once the container is removed therefrom. Further, while containers employing a durable shell or cushioning material may reduce the incidence of ruptures, such containers provide no protection from exposure to the container's contents when a rupture occurs. Additionally, the rupture of such a container generally ruins the container and results in a loss of the entire contents thereof.

Therefore, a container that has improved protection characteristics, including protection which remains in place during use of the container, and protection which allows the contents of the container to be salvaged, would be considered a significant advancement in the art.

SUMMARY OF THE INVENTION

It has been recognized that it would be advantageous to develop a container which has multiple protective characteristics integrated into the container. The present invention provides a protective container for containing a material and protecting against adverse exposure to the material, comprising a durable outer casing; an inner casing in direct contact with the material, which is less durable than the outer casing; and a layer of a preventative agent disposed between the inner and outer casings for disabling the material upon failure of the inner casing.

In accordance with a more detailed aspect of the present invention, the protective container includes a preventative agent which creates physical and/or chemical barriers to the contained material. The nature of the preventative agent is such that on contact thereof with a particular contained material for which exposure to the surrounding environment is undesired, a reaction occurs that renders the contained material relatively harmless or so modifies or restrains it as to significantly reduce, inhibit or prevent the possibility of its uncontrolled release. The composition of the

preventative agent in any of the presented embodiments will be tailored to and governed by its intended application.

In accordance with another more detailed aspect of the present invention, the container may include a preventative agent which is made of one or more components such as adsorbents, chemical antidotes, fire retardants, foaming agents, cyanoacrylates, and gelling agents. The components within the preventative agent may be mixed or segregated into discrete layers depending on the desired protective characteristics.

In accordance with yet another aspect of the present invention, the protective container is designed to contain particular materials in solid, liquid, or vapor form which are flammable, colored, acidic, caustic, toxic, etiological, highly reactive, explosive, biologically hazardous waste, poisonous, irritant, corrosive, highly compressed gas, hazardous waste, medical hazardous waste, radioactive, and mixtures thereof.

In another aspect of the present invention, the protective container is designed to allow dispensing and use of the contained material without losing the protective characteristics of the container.

In another more detailed aspect of the present invention, after failure of the inner casing and disabling of a portion of the material remains functional for use after another portion has been disabled by the preventative agent.

Additional features and advantages of the invention will be apparent from the detailed description which follows, taken in conjunction with the accompanying drawings, which together illustrate, by way of example, features of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross section view of a protective container having a durable outer casing, a protective agent layer, and an inner casing that is less durable than the outer casing in accordance with one embodiment of the present invention;

FIG. 2 is a cross section view of a protective container having a durable outer casing, a plurality of protective agent layers, and an inner casing that is less durable than the outer casing in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

Definitions

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the exemplary embodiments illustrated in the drawings, and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. Any alterations and further modifications of the inventive features illustrated herein, and any additional applications of the principles of the invention as illustrated herein, which would occur to one skilled in the relevant art and having possession of this disclosure, are to be considered within the scope of the invention.

In describing and claiming the present invention, the following terminology will be used.

The singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a layer" includes one or more layers, reference to "an absorbent material" includes one or more absorbent materials, and reference to "the preventative agent" includes one or more of such agents.

As used herein, "material" and "contained material" may be used interchangeably, and refer to a material held in a container, the inadvertent exposure of which, would be undesirable or adverse. A number of reasons may be presented as to why inadvertent exposure of the material may be undesirable or adverse, such as potential hazard to an individual's health, potential damage to the surrounding environment including degradation or discoloration, or a reduction or loss of material volume inside the container.

As used herein, "preventative agent" refers to an agent which is capable of physically or chemically reacting with a material in a manner which disables the material. A wide range of physically and chemically reactive agents are known and must be individually selected by one of ordinary skill in the art to disable a specific material. Examples of preventative agents include without limitation, adsorbents, gelling agents, foaming agents, chemical antidotes, polymer forming agents, fire retardants, etc.

As used herein, "physically reacting" refers to a physical interaction between a preventative agent and a material which physically disables the material, such as entrapping, adsorbing, absorbing, suspending or otherwise arresting the material.

As used herein, "chemically reacting" refers to a reaction between a preventative agent and a material which chemically disables the material by changing the chemical structure and/or nature thereof, such as by neutralizing.

As used herein, "disable" refers to the chemical or physical deactivation of a material by a preventative agent, such that adverse or undesirable circumstances resulting from exposure of the material are ameliorated or eliminated.

As used herein, "outer casing" refers to a barrier between the contents of a container an the outside, and which forms an exterior surface of the container.

As used herein, "inner casing" or "container lining" may be used interchangeably and refer to a barrier in direct contact with the contents of a container, which is placed between the contents of the container and an outer casing of the container.

As used herein, "chemical antidote" refers to any composition which chemically reacts with the contained material in a manner so as to chemically alter the material and render it substantially disabled. It is of particular note that in the use of the present invention, specific chemical antidotes will be selected by one of ordinary skill in the art and employed based on the particular type of materials to be contained in the container.

As used herein, "polymer forming agent" refers to an agent which polymerizes upon contact with a material contained in the container and forms a polymer therewith.

As used herein, "hazardous" and "toxic" may be used interchangeably and refer to a material or combination of materials, that because of its quantity, concentration, or physical, chemical or infectious characteristics, may pose a substantial present or future risk to the health, safety, or welfare, of an animal (including humans), or to the quality of the environment when exposed thereto.

As used herein, "etiological material" refers to a material or combination of materials which causes or substantially contributes to causing a disease or disorder in biological organisms.

As used herein, "explosive material" refers to a material or combination of materials that causes a sudden, almost instantaneous release of pressure, gas, and/or heat when subjected to sudden shock, pressure, spark, or high temperature. In one aspect, "explosive material" includes highly reactive materials which react violently when combined with various other substances, such as sodium metal and water.

As used herein "durable" refers to the ability of a material to resist rupturing under various stress conditions, such as various temperature, pressure, and impact conditions. It is to be noted that durability is not only assessed by the degree of hardness, but also by other characteristics which aid in resisting rupture, such as elasticity or flexibility, thermal conductivity, various chemical properties, etc.

As used herein, in context of the contained material, "use" refers to any suitable, appropriate, or designed employment of the material as dictated by its specific physical or chemical properties which is recognized by one of ordinary skill in the relevant art. Such use is also considered to encompass preparatory actions or steps which are required in order to place the material in a suitable posture for its intended use, such as dispensing the material from one container to another. By way of example, a "use" for gasoline may be powering an internal combustion engine, "use" of an ink may be printing, and "use" of helium may be inflation of a balloon.

As used herein, in context of the container, "use" refers to any suitable, appropriate, or designed employment of the container, including storing, dispensing, heating, cooling, transporting, mixing, and reacting materials.

Invention

The present invention encompasses a container designed to prevent or ameliorate inadvertent or adverse exposure of a material contained therein. Referring now to FIG. 1, is shown a cross section of a protective container 10, having a durable outer casing 15, an inner casing 25, which is less durable than the outer casing, and a layer of a preventative agent 20 disposed therebetween. The container is designed to hold a material 30, and may take any shape or size as required to enable a specific use or accommodate a specific material.

The durable outer casing 15 of the container 10 may be constructed from a wide variety of materials such as polymers, metal, fabric or wood, and be made to durability specifications as needed to meet the requirements of a particular use. Such

specifications may generally be determined by one of ordinary skill in the art on a case by case basis without undue experimentation. However, in one aspect, the outer casing may be made of a hard material which is moderately to highly impact resistant, such as a metal, wood, or rigid polymeric materials like plastics, etc. In another aspect, the outer casing may be made of flexible material which allows the container to conform to a shape dictated by its surroundings, such as a fabric, or flexible polymer material. In any case, the outer casing must be sufficiently durable to protect the contents 30 from minimal impacts, as well as other stresses, and the external environment.

The inner casing 25 is designed and constructed to be less durable (i.e. more easily ruptured or compromised) than the outer casing 15. The purpose of constructing the inner casing in such a manner is to allow a breach of containment by the inner casing before the outer casing becomes compromised when the container is subjected to various stress conditions. The choice of relative durabilities for the inner and outer casings will be governed by the type of material 30 which is contained, and the intended use of the container as determined by those skilled in the art. Further, the specific materials selected for the inner casing will be dictated in part by the contents which the container is to hold. Specifically, since the inner casing is in direct contact with the contents of the container over a large surface area, the inner casing must be made of a material which is unreactive with the container's contents, and which does not become degraded or weakened by contact therewith. Examples of suitable materials for the inner casing may include without limitation, polymeric materials including plastics, metals, glass, paper, fabric, etc.

Disposed between the inner casing 25 and the outer casing 15 is a layer of a preventative agent 20, which is designed to disable the contained material 30 upon contact therewith. As shown in FIG. 2, a plurality of preventative agent layers, 20, 22, and 24 may be used. The preventative agent layer may be made of any suitable agent which is capable of disabling the contained material or a portion thereof. Such a disabling effect may be achieved by either physical or chemical reactions, or both, between the preventative agent and the contained material. Because the purpose of the preventative agent is to disable the contents of the container, the specific preventative agent used will most often be selected based on its ability to physically

or chemically react with a specific material to be contained in the container. The determination of an appropriate combination of contents and preventative agent layer may be readily made using the knowledge and skill of one of ordinary skill in the art without undue experimentation.

In use, the design of the inner casing to be less durable than the outer casing 15 allows the preventative agent time to disable the material 30 before the material is allowed to escape from the container 10. Further, if physically disabled by the preventative agent, the material may be partially or wholly prevented from escaping out of the container. In some aspects, the barrier presented by the outer casing may aid in distributing the contained material throughout the layer(s) of preventative agent and increase the disabling action. The present invention is therefore designed such that any actual exposure to the contained materials will be dramatically reduced or the nature of the material so changed such that exposure is less adverse than to the original contained material.

In accordance with one aspect of the present invention, the container 10 may be designed in a manner which allows the preventative agent layer 20 to remain in place while the contents 30 of the container are in use. In such a case, the outer casing 15 and the inner casing 25 are coupled together in some manner, allowing the container to be an integrated device. One example of the particular usefulness of such a container would be a vehicle fuel tank. Another example, would be an inkjet ink cartridge. Yet another example would be a spray bottle or spray can full of a cleaning solution, insecticide, paint, etc. Additional examples would be batteries , portable power devices to power portable electronic appliances.

In yet another aspect of the present invention, the preventative agent layer 20 may disable a portion of the contained material 30 without disabling all of the contained material, thus allowing a portion thereof to remain enabled and useful. As such, when a container 10 becomes damaged, a portion of the contents may still be salvaged and used.

As noted above, a very wide variety of materials, in nearly any physical form, such as solid, semi-solid, liquid, and vapor, may be used in connection with the container of the present invention. In short, any material may be used with the container of the present invention which would cause undesirable or adverse

circumstances if inadvertent exposure of the material occurred. In one aspect of the present invention, the contained materials may include, but are not limited to materials which are flammable, colored, acidic, caustic, neutral, etiological, pharmacologically active, explosive, and radioactive, combustible, as well as mixtures thereof.

Flammable materials generally include any material having a flashpoint below about 100° F. Specific examples of flammable materials include without limitation, alcohols, such as methanol, ethanol, propanol, etc., combustible alkanes such as methane, ethane, propane, butane, etc., and petroleum products, such as various grades of oil, diesel fuels, reactive metals, metal hydrides and hydride complexes, and gasoline.

Colored materials generally include any material which reflects one or more wavelengths of light. In one aspect, colored materials may include a colored dye or pigment. Specific examples of colored materials include without limitation, inks, ink-jet inks, toners, fusible toners, paints, stains, lacquers, varnishes, and other colored or tinted consumer chemicals such as propylene glycol and diesel fuels.

Acidic materials generally include any material having a pH of about 6 or lower. Specific examples of acidic materials include without limitation, inorganic acids, such as sulfuric acid, hydrochloric acid, nitric acid, phosphoric acid, iodic acid, and fluoric acid, as well as organic acids, such as carboxylic acids, including acetic acid, citric acid, and dicarboxylic acids including oleic, maleic, and succinic acids.

Caustic materials include a variety of basic materials, (i.e. having a pH of about 8 or higher), particularly, materials which are strongly basic. Specific examples of caustic materials include hydroxide salts, such as sodium hydroxide, calcium hydroxide, aluminum hydroxide, magnesium hydroxide, ammonium hydroxide as well as other strongly alkaline materials

Neutral materials are generally those materials having a pH of from about 6 to about 8. Specific examples of neutral materials include without limitation, water, neutralized acids, or bases and other solutions which exhibit neither strongly acidic nor strongly basic properties.

As defined above, etiological agents are generally agents which cause or substantially contribute a disease or physiological disorder. Specific examples of

etiological agents include without limitation, bacteria, fungus, toxins, irritants, biohazardous waste such as blood and other fluid or tissue samples, poisons such as arsenic, mercury, and hydrofluoric acid, and carcinogens such as PCBs.

Pharmacologically active materials are generally those materials which have a therapeutic or positive effect on the body including a counteractive effect on a disease or disorder. Examples of specific pharmacologically active materials include without limitation, antibiotics antithrombotics and hemostatics, histamine receptor agonists and antagonists, antidepressants agents, antihypertensives, anti-inflammatories, decongestants, sedatives, tranquilizers and mixtures thereof.

As recited above, explosive materials are generally, materials that causes a sudden, almost instantaneous release of pressure, gas, and/or heat when subjected to sudden shock, pressure, spark, or high temperature. Further, explosive materials may also include highly reactive materials which react violently when combined with various other substances. Specific examples of explosive materials include without limitation, nitroglycerin, trinitrotoluene (TNT), C4, aged picric acid, and compressed gas or liquid. Further, examples of highly reactive materials include without limitation, heavy alkali metals, high purity chemicals, and materials which are unstable at near ambient conditions.

Radioactive materials are generally materials which emit one or more forms of radiation, such as alpha, beta, or gamma radiation. Specific examples of radioactive materials include without limitation, radioisotopes of various elements, such a plutonium and uranium, as well as any tagged chemical compounds.

It is to be understood that the above recited lists of various specific materials are intended to merely illustrate some of the types of materials which may be used in connection with the container of the present invention, and are not intended to limit the scope thereof. Further, such materials may be used with the container of the present invention in a variety of forms including clean and waste forms of both hazardous and non-hazardous types of materials.

As recited above, the preventative agent used in the present invention includes substances and/or mechanisms which disable or otherwise make less harmful the contained material. As such, the preventative agent may present physical and/or chemical characteristics which act to disable the contained material. A wide variety

of preventative agents may be used in the container of the present invention, several of which may be in its separate layer and containment in a given package, and as noted above, the specific preventative agent may be selected based upon the material which the container is to hold. Such a selection may be readily made using the knowledge of one ordinarily skilled in the art without being required to engage in undue experimentation.

Referring again to FIG. 1, the preventative agent layer 20 may be made of a single preventative agent, or may include a mixture of preventative agents. Likewise in FIG. 2, each of the preventative agent layers 20, 22, and 24 may each be made of a single preventative agent, or a mixture of preventative agents. The specific preventative agent, or mixture of agents contained in each layer may be customized in order to achieve a particularly desired result. Likewise, the combination of different layers may be customized to achieve a specific result. In short, the number of possible preventative agents and mixtures thereof, as well as different layer combinations which are capable of being used in the present invention are only limited by the number and types of materials which the container may contain.

Because of the wide variety of preventative agents which may be used in connection with the present invention, reference will only be made to a few specific classes and species which are representative of the much larger group of preventative agent which is contemplated to be within the scope of the present invention. Accordingly, in one aspect of the present invention, the preventative agent may be a foaming agent. A wide variety of foaming agents may be used with the container of the present invention. However, specific examples of foaming agents which may be used include without limitation, carbonates such as sodium bicarbonate and ammonium bicarbonate, polyolefin foams, and other alkali metal carbonates, or surfactants.

In another aspect of the present invention, the preventative agent may be a polymer forming material. Generally, such a material will be selected to form a hard polymer with the contained material, upon contact therewith to provide a sealant that forms a barrier which is essentially impermeable to the contained material. Initiation of polymerization may be accomplished through either the contained material or an initiator included within the preventative agent. Specific examples of polymeric

agents include without limitation, cyanoacrylates as well as other polymerizable compounds. Further, cyanoacrylate monomers include α-cyanoacrylate esters and corresponding initiators which may include amines, sodium hydroxide, sodium carbonate, other compatible Lewis bases. Self-initiation may also occur via free radicals.

In yet another aspect of the present invention, the preventative agent may be a fire retardant. Specific examples of fire retardants include without limitation, bromides such as brominated polystyrenes, bromine chloride, and phosphines such as phosphate salts, phosphate esters, nitrogen-containing phosphorus derivatives, phosphoric acid derivatives, phosphinates, phosphites, phosphonites, phosphinites, and phosphines. Other compounds which have found use as fire-retardants include inorganic compounds such as antimony compounds like antimony trioxide, antimony pentoxide, and sodium antimonite, boron compounds such as zinc borate, boric acid and sodium borate, alumina trihydrate and molybdenum oxides, halogenated compounds such as including decabromodiphenyl oxide, chlorendic acid, tetrabromophthalic anhydride, and similarly halogenated compounds. The halogenated compounds, especially chlorinated compounds, are often combined with inorganic compounds, especially antimony-, iron-, cobalt-, nickel-, molybdenum-, and other metal-containing compounds, to produce fire-retarding effects.

In a further aspect of the invention, the preventative agent may be a chemical antidote. As recited above, a chemical antidote is any composition which chemically reacts with the contained material in a manner so as to chemically alter the material and render it substantially disabled. Generally, chemical antidotes include chemical compounds known to react with the contained material to produce products which are less harmful, (i.e. reacting a basic compound with a contained acid, etc.). For example, if the contained material is a biological or etiological material the chemical antidote may be a chemical or biocide which neutralizes or immobilizes the contained material. It is to be understood that the choice of specific chemical antidote will depended in large measure on the type of material being contained, and that such a choice is considered well within the skill of those in the art. An example of antidote is egg yolk proteins or dried egg proteins.

In an additional aspect of the present invention, the preventative agent may be a gelling agent. A wide variety of gelling agents may be used in connection with the present invention and may be determined by in part by the specific material being contained. Specific examples of gelling agents include without limitation, alginate, polyacrylate salt, surfactants such as laurol glutamic butylamide, carboxymethyl cellulose, cellulose ether, polyvinylpyrrolidone, starch, dextrose, gelatin, sterate and sterate salts, lamallae and liposome or vesicle forming surfactants, lecithins, pectin, coagulants such as sulfate salts, and fluid thickeners such as substituted succinic acids or polyoxyalkylene reaction products, may be included such that upon contact with the contained material a gel is formed which substantially immobilizes the contained material.

In accordance with yet another aspect of the present invention, the preventative agent may be an adsorbent agent. Adsorbents generally physically disable a contained material when placed in contact therewith. A wide variety of adsorbents may be used in connection with the container of the present invention, and the specific choice of adsorbent may be based in part on the material contained in the container. Such choices are deemed to be well within the capacity of one skilled in the art without requiring undue experimentation. Specific examples of adsorbent agents include without limitation, vermiculite, high porosity clay, polyurethane foams, fibrous cellulose, fibrous polyacrylates, fibrous acrylic polymers, fibrous thermoplastics, plastic microspheres, glass microspheres, and ceramics which adsorb and immobilize the contained material and prevent evaporation and/or uncontrolled release. Despite the use of the term "adsorbent" any material which is absorbent is also included in the scope of the present invention, and several of the listed components may be more correctly referred to as absorbent.

In keeping with the present invention, the container 10 is so designed such that if a portion of the material 30 is disabled after failure if the inner casing 15 a portion of the material remaining unaffected may be used as originally intended. For example, an ink cartridge according to the present invention having an adsorbent and cyanoacrylate preventative agent layers. Upon a breach of the inner casing a portion of the ink would be adsorbed and the cyanoacrylate polymerized. However, the ink

remaining in the inner casing of the cartridge may still be dispensed and used for printing purposes without detrimental effects in performance.

In accordance with another aspect of the invention, the preventative agent remains in a position capable of disabling the material 30 during use thereof. Thus, the preventative agent is integrated into the container 10 and is situated to disable the material upon failure of the inner casing 15. In this respect, the preventative agent is not designed to be removable from the container or the inner and outer casings.

In accordance with yet another aspect of the present invention, additional mechanisms are included which identify ~~density~~ changes within the contained material and display the information using color changes visible from the outside of the container. An example of such indicators include pH indicators such as phenolphthalin. Other dyes and or metal complexing agents as described in color index may be used as appropriate.

It is to be expressly understood that any one or more of the above-recited preventative agents may be used in combination with any one or more of the above-recited contained materials. Such combinations, as well as combinations with preventative agents or contained materials not specifically recited may be made using the knowledge of one skilled in the art without the necessity of engaging in undue experimentation.

The following examples illustrate various embodiments and combinations of preventative agents and contained materials. The following examples should not be considered as limitations of the present invention, but should merely teach the methods of the present invention.

Example 1

An ink cartridge is constructed using 0.05 mm thick plastic film with thin aluminum coating as the inner casing and a high density polyethylene as the outer casing. The free space defined by the inner casing is 60 ml. The spacing between the inner and outer casings is filled with a highly adsorbent acrylate polymer powder commonly available in stores as 'planter's ice' , which adsorbs any released ink. Within the polyurethane adsorbent is placed ethyl cyanoacrylate monomers which

polymerize upon contact with the ink which contains 20 mg polyethylene amine per gram of ink.

Example 2

A fuel container is constructed using polypropylene as the inner casing and aluminum as the outer casing. The spacing between the inner and outer casings is filled with polyacrylate salt and Lauroyl Glutamic acid-butylamide, which gels upon contact with any released fuel. In a separate layer between the gelling layer and the outer casing a brominated polystyrene layer is placed which acts as a fire retardant.

It is to be understood that the above-described arrangements are only illustrative of the application of the principles of the present invention. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the present invention and the appended claims are intended to cover such modifications and arrangements. Thus, while the present invention has been shown in the drawings and fully described above with particularity and detail in connection with what is presently deemed to be the most practical and preferred embodiments of the invention, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, variations in size, materials, shape, form, function and manner of operation, assembly and use may be made, without departing from the principles and concepts of the invention as set forth in the claims.

What is claimed is: